Tropical infections caused by *Staphylococcus aureus*

Michael Ellis, MD
Infectious Diseases Division
Uniformed Services University of the Health Sciences
February 2015
Tropical infections caused by *S. aureus*

Outline

- Introduction
- Tropical Pyomyositis
- Cutaneous infections
- Prevention
- Bites
S. aureus
Microbiology

• Gram-positive cocci
• Grape-like clusters on gram stain
• Catalase positive
• Coagulase positive
• β-hemolysis on sheep blood agar
• MRSA
  – Identified based on oxacillin susceptibility
  – Can be identified using chromogenic agar
  – Rapid identification using PCR to detect mecA
Hospital-associated MRSA

Risk groups

Zyvox (linezolid) advertisement.
Community-associated MRSA
Risk groups

- Household contacts of CA-MRSA infected persons
- Athletes
- Children
- Prison inmates
- Soldiers
- MSM
- IVDA

What is CA-MRSA?

Methods of description

- Epidemiological and clinical characteristics
  - Occurs in the community or <48-72h after admission
  - Absence of traditional risk factors for MRSA
  - Primarily cause skin and soft tissue infection (SSTI)

- Molecular characteristics
  - Presence of resistance and virulence factors
    - Staphylococcal cassette chromosome *mec* (SCCmec) type IV
    - Panton-Valentine leukocidin (PVL)
  - Pulsed-field types (PFTs) USA300
    - Predominant strain in U.S.
## Community-associated MRSA

### Molecular characteristics

<table>
<thead>
<tr>
<th>PFT</th>
<th>Location</th>
<th>SCCmec</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA300</td>
<td>Community</td>
<td>Type IV</td>
</tr>
<tr>
<td>USA400</td>
<td>Community</td>
<td>Type IV</td>
</tr>
<tr>
<td>USA100</td>
<td>Hospital</td>
<td>Type II</td>
</tr>
<tr>
<td>USA200</td>
<td>Hospital</td>
<td>Type II</td>
</tr>
</tbody>
</table>

### MLST

<table>
<thead>
<tr>
<th>MLST</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>45</td>
</tr>
<tr>
<td>36</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

Adapted from J Clin Microbiol. 2003;41:5113.
Tropical Pyomyositis
Tropical pyomyositis

Pathogenesis

- Pyomyositis is a primary infection of skeletal muscle
  - Does not arise from contiguous site
  - Result of transient hematogenous seeding
  - Usually associated with abscess formation

- Pathogenesis is poorly understood

- Associated risk factors
  - Trauma
  - Immunodeficiency (but most are healthy)
  - Injection drug use
  - Concomitant parasitic infection (e.g., toxocara)
  - *S. aureus* strain virulence
Tropical pyomyositis
Pathogenesis-risk factors

• 25%-50% of pyomyositis associated with trauma
  – Includes strenuous exercise

• Normal skeletal muscle sequesters iron and is relatively resistant to infection
  – Fewer than 1% of *S. aureus* bacteremia deaths reveal skeletal muscle abscesses

• Damaged muscle
  – Increased perfusion
  – Hematoma formation
    • Provides binding site
    • Provides iron for bacteria
Tropical pyomyositis
Pathogenesis- risk factors

• HIV
  – Noted in African studies as significant independent risk factor
  – T-cell dysfunction
  – HAART toxicity
  – Primary HIV myopathy
  – Increased *S. aureus* carriage

• Others- DM, sickle cell, cirrhosis

• Injection drug use
  – Frequent *S. aureus* bacteremia
  – Increased *S. aureus* carriage
Tropical pyomyositis

Epidemiology

• Accounts for 1-4% of hospital admissions in tropical countries
• Increasingly reported in temperate regions
  – Likely a reflection of the emergence of CA-MRSA
• More common in males (1.5:1)
• Peak age groups
  – 2-5 years
  – 20-45 years
• Peak season in the tropics appears to be July-September
• *Staphylococcus aureus* - 90%
  – CA-MRSA has emerged as an important pathogen
• Group A streptococcus - 1-5%
• Other pathogens
  – Non-Group A strep
  – Pneumococcus
  – Gram negative enteric (e.g., *E. coli*)
  – Mycobacterial (TB)
  – Polymicrobial
Tropical pyomyositis
Clinical manifestations

• Presents with fever and localized cramping muscle pain
  – Usually single muscle group
  – May be multiple in up to 20% of cases
  – Lower extremities- but any muscle group possible

• Described in 3 clinical stages
  – Stage 1 (invasive)-
  – Stage 2 (suppurative)
    • Most patients present during this stage
  – Stage 3 (late)- systemic toxicity/infection
Tropical pyomyositis
Clinical manifestations

• Stage 1 (invasive)
  – Low-grade fever, mild leukocytosis
  – “Woody” muscle induration

• Stage 2 (suppurative)- 10-21 days after initial symptoms
  – Fever, high leukocytosis
  – Exquisite muscle tenderness, edema, and often fluctuance
  – Aspirate will yield purulent material

• Stage 3 (late)- systemic toxicity/infection
  • Septic shock
  • Endocarditis
  • Pneumonia
  • Abscesses
Tropical pyomyositis
Clinical manifestations

• Stage 1 (invasive)
  – Low-grade fever, mild leukocytosis
  – “Woody” muscle induration

• Stage 2 (suppurative) - 10-21 days after initial symptoms
  – Fever, high leukocytosis
  – Exquisite muscle tenderness, edema, and often fluctuance
  – Aspirate will yield purulent material

• Stage 3 (late) - systemic toxicity/infection
  • Septic shock
  • Endocarditis
  • Pneumonia
  • Abscesses
Left posterior thigh- stage 2 pyomyositis
CT fluid collection - stage 2 pyomyositis
Tropical pyomyositis

Clinical manifestations

• Stage 1 (invasive)
  – Low-grade fever, mild leukocytosis
  – “Woody” muscle induration

• Stage 2 (suppurative)- 10-21 days after initial symptoms
  – Fever, high leukocytosis
  – Exquisite muscle tenderness, edema, and often fluctuance
  – Aspirate will yield purulent material

• Stage 3 (late)- systemic toxicity/infection
  • Septic shock
  • Endocarditis
  • Pneumonia
  • Abscesses
Necrotizing pneumonia
Endocarditis
Septic emboli
Tropical pyomyositis
Differential diagnosis

– Muscle contusion
– Cellulitis
– DVT
– Osteomyelitis
– Septic arthritis
– Neoplasm (osteosarcoma)
– Clostridial myonecrosis
– Necrotizing fasciitis
– Trichinosis
– Cysticercosis
Tropical pyomyositis

Diagnosis

• All patients should be evaluated for endocarditis

• Radiography
  – MRI (preferred), US, CT
  – Diagnostic guided drainage prior to antibiotics

• Labs
  – Leukocytosis
  – Elevated ESR/CRP
  – CPK usually normal

• Cultures
  – Blood cultures positive in at least 10% of cases
  – Positive in 30% of temperate pyomyositis (due to technique)
Coronal CT image of psoas abscess
Tropical pyomyositis

Treatment

• Stage 1 (invasive)- antibiotics alone may be effective

• Stage 2 and 3
  – Drainage- percutaneous or surgical
  – Antibiotics (at least 2-3 weeks duration)
    • Vancomycin
    • Oxacillin
    • Cefazolin
  • Add Gram-negative and anaerobic coverage for immunocompromised
Left hip- stage 2 pyomyositis
Left hip- stage 2 pyomyositis- post drainage
Cutaneous *S. aureus* infections
Cutaneous *S. aureus* infections

Manifestations

- **Folliculitis**
- **Furuncles (abscesses)**
  - May be multiple
  - Recurrence is common
  - Outbreak settings/families
- **Purulent cellulitis**
  - Associated with abscess/ulcer
- **Nonpurulent cellulitis**
  - Contribution is unknown
Folliculitis- leg
Cellulitis- knee
Abscess-foot

Photo Credit: Major Kirk Waibel, MD
Abscess- knee

<table>
<thead>
<tr>
<th>Study number:</th>
<th>2155</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>5 Nov 2013</td>
</tr>
<tr>
<td>Anatomic site:</td>
<td>Knee</td>
</tr>
</tbody>
</table>
Abscess- axilla
Dermatologic conditions of the ill returned traveler: an analysis from the GeoSentinel Surveillance Network

Edith R. Lederman a,b,1,*, Leisa H. Weld b,1, Iqbal R.F. Elyazar a,1, Frank von Sonnenburg c,1, Louis Loutan d,1, Eli Schwartz e,1, Jay S. Keystone f,1

Dermatologic conditions in travelers

Epidemiology

• GeoSentinel Surveillance Network data
  – 1997-2006
  – 4742 encounters for dermatological complaints
    • 18% of all encounters

• Skin lesions in returning travelers
  – Cutaneous larvae migrans (9.8%)
  – Insect bite (8.2%)
  – Skin abscess (7.7%)
  – Infected insect bite (6.8%)

Community-Acquired Methicillin-Resistant Staphylococcus aureus in a Returned Traveler

Rabin K. Shrestha, MD,* Ravindran A. Padmanabhan, MD, MRCP,† Louis D. Saravolatz, MD, MACP,‡ Geraldine S. Hall, PhD,* and Steven M. Gordon, MD†
Community-Acquired Methicillin-Resistant Staphylococcus aureus in a Returned Traveler

Rabin K. Shrestha, MD,* Ravindran A. Padmanabhan, MD, MRCP,† Louis D. Saravolatz, MD, MACP,‡ Geraldine S. Hall, PhD,* and Steven M. Gordon, MD†

- 65-year-old man who had returned from 4 wks in DRC
- Developed R leg swelling and pain during return trip
- CA-MRSA leg abscess
- CA-MRSA bacteremia
- CA-MRSA genotype, PVL+, SCCmec IV
Methicillin-Resistant *Staphylococcus aureus* Infections in U.S. Service Members Deployed to Iraq

MAJ Stephen S. Roberts, MC USA*; COL Robert J. Kazragis, MC USA†

ABSTRACT  Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) has become the most common cause of skin and soft-tissue infections in the United States. However, no studies have yet examined its importance in the deployed environment. We retrospectively reviewed culture results obtained at a level II military treatment facility in Iraq over a 5-month period to determine the incidence of CA-MRSA in this population. Eighty-five percent of the cultures obtained from skin abscesses were positive for *S. aureus*, and 70% were methicillin-resistant *S. aureus*. All of the isolates recovered were sensitive to trimethoprim/sulfamethoxazole. CA-MRSA is a significant problem in deployed service members and civilians and empiric antibiotics for skin and soft-tissue infections need to provide coverage for this important pathogen.

- Military treatment facility-Baghdad 2008
- 66 SSTI abscesses
- 26 abscesses cultured
  - 22/26 *S. aureus*
  - 70% MRSA
Methicillin-Resistant *Staphylococcus aureus* in Wound Cultures Recovered From a Combat Support Hospital in Iraq

Clinton K. Murray, MD, Matthew E. Griffith, MD, Katrin Mende, PhD, Charles H. Guymon, MS, Michael W. Ellis, MD, Miriam Beckius, MPH, Wendy C. Zera, BS, Xin Yu, MS, Edgie-Mark A. Co, PhD, Wade Aldous, PhD, and Duane R. Hospenthal, MD, PhD

### TABLE 2. Molecular Characteristics of Isolates, Including Pulsed-Field Types, SCCmec Resistance Genes, and ACME and PVL Virulence Genes

<table>
<thead>
<tr>
<th>Pulsed-Field Types (n)</th>
<th>SCCmec, n (%)</th>
<th>Presence of ACME, n (%)</th>
<th>Presence of PVL, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA300 (66)</td>
<td>IV 66 (100)</td>
<td>62 (94)</td>
<td>66 (100)</td>
</tr>
<tr>
<td>USA1100 (4)</td>
<td>IV 2 (50), NA 2 (50)</td>
<td>0 (0)</td>
<td>4 (100)</td>
</tr>
<tr>
<td>Type 2 (5)</td>
<td>II 5 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type A (2)</td>
<td>IIIA 1 (50), IIIB 1 (50)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type B (1)</td>
<td>IV 1 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type C (1)</td>
<td>IV 1 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type D (1)</td>
<td>IV 1 (100)</td>
<td>0 (0)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Type E (1)</td>
<td>IA 1 (100)</td>
<td>0 (0)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Type F (1)</td>
<td>IV 1 (100)</td>
<td>0 (0)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Type G (1)</td>
<td>IV 1 (100)</td>
<td>1 (100)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Type H (1)</td>
<td>IV 1 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

J Trauma. 2010;69: S1.
Treatment
Practice Guidelines for the Diagnosis and Management of Skin and Soft Tissue Infections: 2014 Update by the Infectious Diseases Society of America

Dennis L. Stevens,¹ Alan L. Bisno,² Henry F. Chambers,³ E. Patchen Dellinger,⁴ Ellie J. C. Goldstein,⁵ Sherwood L. Gorbach,⁶ Jan V. Hirschmann,⁷ Sheldon L. Kaplan,⁸ Jose G. Montoya,⁹ and James C. Wade¹⁰
MANAGEMENT OF SSTIs

NONPURULENT
Necrotizing Infection /Cellulitis /Erysipelas

Severe
- EMERGENT SURGICAL INSPECTION / DEBRIDEMENT
  - Rule out necrotizing process
- EMPIRIC Rx
  - Vancomycin PLUS Piperacillin/Tazobactam

Moderate
- INTRAVENOUS Rx
  - Penicillin or Ceftriaxone or Cefazolin or Clindamycin
- ORAL Rx
  - Penicillin VK or Cephalosporin or Dicloxacillin or Clindamycin

Mild
- ORAL Rx
  - I & D C & S

Defined Rx (Necrotizing Infections)
Monomicrobial Streptococcus pyogenes
- Penicillin PLUS Clindamycin
Clostridial sp.
- Penicillin PLUS Clindamycin
Vibrio vulnificus
- Doxycycline PLUS Ceftazidime
Aeromonas hydrophila
- Doxycycline PLUS Ciprofloxacin
Poly microbial
- Vancomycin PLUS Piperacillin/Tazobactam

Defined Rx MRSA
- See Empiric M SSA
- Nafcillin or Cefazolin or Clindamycin

Defined Rx M SSA
- Dicloxacillin or Cephalaxin

PURULENT
Furuncle / Carbuncle / Abscess

Severe
- EMPIRIC Rx
  - Vancomycin or Daptomycin or Linezolid or Televancin or Televancin or Clindamycin

Moderate
- EMPIRIC Rx
  - TMP/SMX or Doxycycline

Mild
- I & D

1 Since daptomycin and televancin are not approved for use in children, vancomycin is recommended; clindamycin may be used if clindamycin resistance is <10-15% at the institution.
SSTI management

Furunculosis
SSTI management
Furunculosis-outpatient

- Incision and drainage - most important intervention
- Antimicrobial therapy recommended for:
  - Severe or extensive disease
  - Signs/symptoms of systemic illness (Fever, tachy, leukocytosis)
  - Rapid progression
  - Extremes of age
  - Comorbid conditions/immunosuppression
  - Abscess on face, hand, groin
- Send specimen for culture
- Duration - 5 days therapy
- Timely follow-up (24-72 hours)
Randomized, Controlled Trial of Antibiotics in the Management of Community-Acquired Skin Abscesses in the Pediatric Patient

Myto Duong, MD, MS
Stephen Markwell, MA
John Peter, MD
Stephen Barenkamp, MD

From the Cardinal Glennon Children’s Medical Center, Saint Louis University School of Medicine, Pediatric Emergency Medicine Department (Duong, Peter) and Pediatric Infectious Diseases Division, Department of Pediatrics (Barenkamp), Division of Pediatrics, St. Louis, MO; and the Southern Illinois University, School of Medicine, Division of Statistics and Research Consulting, Springfield, IL (Markwell).

Study:

- 161 Pediatric patients (80% MRSA)
- I&D + TMP/SMX vs. I&D + placebo for 10 days
- Placebo cure: 95%
- TMP/SMX cure: 96% difference NS
Nonpurulent cellulitis

- Etiology- β-hemolytic streptococci (less likely *S. aureus*)
- Empirical coverage for MRSA:
  - Evidence of MRSA
  - MRSA colonization
  - Penetrating trauma
  - Immune-compromised
  - Systemic toxicity

- Timely follow-up (24-72 hours)
SSTI management

Cellulitis

• Adjunctive measures
  – Elevate and rest affected limb
  – Treated tinea pedis
  – Address pre-disposing conditions
    • Extremity edema
    • Dermatological conditions
Clinical Trial: Comparative Effectiveness of Cephalexin Plus Trimethoprim-Sulfamethoxazole Versus Cephalexin Alone for Treatment of Uncomplicated Cellulitis: A Randomized Controlled Trial

Daniel J. Pallin,1,2 William D. Binder,3 Matthew B. Allen,1,4 Molly Lederman,1,5 Siddharth Parmar,1 Michael R. Filbin,3 David C. Hooper,6 and Carlos A. Camargo Jr3

Study:

- 153 patients (children and adults) nonpurulent cellulitis
- Cephalexin + TMP/SMX vs. Cephalexin + placebo 14d
- Placebo cure: 82%
- TMP/SMX cure: 85% difference NS
- No benefit to MRSA coverage
S. aureus prevention
Personal Prevention of MRSA Skin Infections

Protect yourself through good hygiene.
The key to preventing MRSA infections is for everyone to practice good hygiene:

1. Keep your hands clean by washing thoroughly with soap and water or using an alcohol-based hand rub.
2. Keep cuts and scrapes clean and covered with a bandage until healed.
3. Avoid contact with other people’s wounds or bandages.
4. Avoid sharing personal items such as towels or razors.

http://www.cdc.gov/mrsa/prevent/personal.html#
Prevent the spread of MRSA if you have it.

Prevent spreading MRSA skin infections to others by following these steps:

1. **Cover your wound.**
   Keep wounds that are draining, or have pus, covered with clean, dry bandages until healed. Follow your healthcare provider's instructions on proper care of the wound. Pus from infected wounds can contain staph, including MRSA, so keeping the infection covered will help prevent the spread to others. Bandages and tape can be discarded with the regular trash.

2. **Clean your hands.**
   You, your family, and others in close contact should wash their hands frequently with soap and water or use an alcohol-based hand rub, especially after changing the bandage or touching the infected wound.

3. **Do not share personal items.**
   Avoid sharing personal items, such as towels, washcloths, razors, clothing, or uniforms, that may have had contact with the infected wound or bandage. Wash sheets, towels, and clothes that become soiled with water and laundry detergent. Use a dryer to dry clothes completely.

4. **Maintain a clean environment**
   Establish cleaning procedures for frequently touched surfaces and surfaces that come into direct contact with your skin.

5. **Talk to your doctor.**
   Tell any healthcare providers who treat you that you have or had a staph or MRSA skin infection. There are things that can be done to protect people that carry staph/MRSA from getting an infection or spreading it to others when they are in the hospital or have surgery.

http://www.cdc.gov/mrsa/prevent/personal.html#
SSTI Prevention
Basic First Aid kit

- Adhesive bandages
- Gauze
- Adhesive tape
- Elastic bandage
- Antiseptic
- Cotton swabs
- Antibacterial ointment
- 1% hyrocortisone cream
- Moleskin
- Thermometer

CDC Yellow Book. 2010, pg 233.
Bites

Human

• Microbiology
  – Aerobic & anaerobic bacteria (oral and skin flora)
  – *Eikenella corrodens* must be covered

• Management/prophylaxis
  – Surgical evaluation (consider primary closure for face - specialist)
  – Emobilize/splint
  – Amox/clav or TMP-SMX + clindamycin
  – Tetanus consideration

• Treatment of infection
  – Obtain cultures
  – IV antibiotics (Amp-sulbactam, Pip-taz, FQN+clinda)
Bites

Dog

• Microbiology- 5% become infected
  – Pasteurella spp, staph, strep, anaerobes
  – Capnocytophaga canimorsus (asplenic, immune suppressed)

• Management/prophylaxis
  – Surgical evaluation (consider form of closure)
  – Emobilize/splint
  – Severe- face, genitals, immune suppressed, crush
    • Amox/clav or TMP-SMX + clindamycin (1st dose IV)
  – Tetanus and rabies consideration

• Treatment of infection
  – Obtain cultures
  – IV antibiotics (Amp-sulbactam, Pip-taz)
Bites

Cat

• Microbiology- 80% become infected
  – *Pasteurella multocida*, staph, strep, anaerobes
  – Develop infection within 24 hours

• Management/prophylaxis- **all** get antibiotics!
  – Surgical evaluation (consider form of closure)
  – X-ray
  – Emobilize/splint
  – Amox/clav or doxycycline, cefuroxime (1\textsuperscript{st} dose IV)
  – Tetanus and rabies consideration

• Treatment of infection (high risk for bone/joint)
  – Obtain cultures
  – IV antibiotics (Amp-sulbactam, FQN + metro, carbapenem)
Questions

Michael Ellis, MD
LTC, MC
Department of Medicine
Infectious Diseases Division
Uniformed Services University of the Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814
(301) 295-2254
Michael.ellis@usuhs.mil